1765

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Thinghao F. Wang

Serial No. 10/071,809

Filing Date: February 7, 2002

For METHOD FOR SELECTIVELY ETCHING SILICON AND/OR METAL SILICIDES

Examiner: Deo, Duy Vu

Group Art Unit No.: 1765

REQUEST FOR RECONSIDERATION

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sirs:

In response to the Official Action of February 17, 2004, Applicant respectfully requests reconsideration in light of the following remarks.

Request for Reconsideration

WSi_x/poly-Si stack structures are used for gate electrodes. It is therefore desirable to have a dry etch that will give a vertical profile and no trenching through the gate dielectric that lies beneath the stack. Fluorine-based etching gases have high etch rates, but have low selectivity to the gate oxide.

Chlorine-based etching gases provide higher selectivity, but are slower than fluorine-based etching. A study of this system indicated that concentrations of O_2 of less than 15% by volume have an improved etch rate, while at concentrations of O_2 of 25% by volume or more etching stops and a film is deposited (see Nojiri, et al., J. Vac. Sci. Technol. B14(3), May/June 1996, p. 1791-1795, cited in an earlier filed Information Disclosure Statement). The present invention makes use of the discovery that, contrary to these teachings, concentrations of O_2 of at least 25% by volume, not only provide high etch rates, but high selectivity over poly-Si, as well as oxide. Selectivities of 30 or more over poly-Si are observed.

The rejection of Claim 12 under 35 U.S.C. § 102 over Bourassa, et al. is respectfully traversed. In the examples of Bourassa, et al. oxygen is not added.

Bourassa, et al. describes an anisotropic silicide etching process. This reference notes that "[o]xygen can be added to this first etch at about 5 SCCM thereby to increase the etch rate by about 16%. However, oxygen also attacks the photoresist so [it] must be added with care, and in the preferred example described herein, it is not used." (col. 3, lines 21-25). Accordingly, although this reference may *suggest* the use of oxygen, there is no specific description of using oxygen having a concentration of greater than 25% by volume specific enough for anticipation. Withdrawal of this ground of rejection is respectfully requested.

The rejection of the claims under 35 U.S.C. § 103 over Bourassa, et al., Tsai, Tabara, et al., individually or in combination, and further in combination with Langley, et al. is respectfully traversed. The claimed invention provides unexpectedly superior etch selectivity ratios, now specified in the claims; the etch rate of metal silicide is at least thirty times greater than the etch rate of poly-Si.

Tsai describes a method of etching metal silicides. Tsai is interested in high selectivity etching of metal silicide with respect to poly-Si (column 1, lines 59-62). The preferred volume ratio is O_2:N_2 of 0.25-5:1, and Cl_2:(O_2+N_2) of 5-20:1 (column 3, lines 26-30); this is a maximum O_2 concentration of about 15%. The greatest selectivity over poly-Si, about 5, is shown in Figure 7. There is no suggestion that greater selectivity may be obtained.

Tabara, et al. describes a conductive layer forming method using etching masks. This reference is concerned with etching WSi_2 or poly-Si, using TiN or TiON as a mask; the etching conditions should selectively etch the metal silicide or poly-Si with respect to the mask (column 2, lines 49-54). Very similar etching conditions, at 1mTorr, are used to etch both WSi_2 and poly-Si: Cl_2/O_2 gas ratios of 25/11 sccm are used for etching WSi_2, and 25/9 sccm are used for etching poly-Si (column 7, lines 9-26).

Figure 20 of Tabara, et al. compares the etch selectivity of WSi_2 and poly-Si to TiN under conditions of 1mTorr with a gas flow rate of Cl_2 of 25 sccm, while varying the O_2 flow rate: for any O_2 flow rate the etch selectivity of Si/TiN is always greater than the selectivity of WSi_2/TiN -- poly-Si is always etched faster than WSi_2 (compare curve on upper left with curve on bottom; all other curves only describe WSi_2/TiON etch selection ratios). Accordingly, there is no suggestion that greater selectivity may be obtained.

Bourassa, et al. has been described above. This reference suggests that the presence of oxygen can be undesirable, and fails to recognize the superior etch selectivity that may be obtained with sufficient oxygen concentrations.

Langley has been cited for describing a breakthrough etch using CF_4. There is no suggestion for achieving high selectivity for poly-Si in a metal silicide etch.

Applicants provide herewith a declaration under 37 C.F.R. § 132 by Krishnaswamy Ramkumar. This declaration describes the data, present in the specification, which indicates that the claimed invention provides superior and unexpected results: etch selectivities of at least 30. These data provided in the specification demonstrate substantially improved results, and these results are unexpected in light of the prior art (specifically Bourassa, et al., Tabara, et al., Tsai, Langley, et al., and Nojiri, et al., J. Vac. Sci. Technol. B14(3), May/June 1996, p. 1791-1795). The declarant further states that these result are commercially significant,

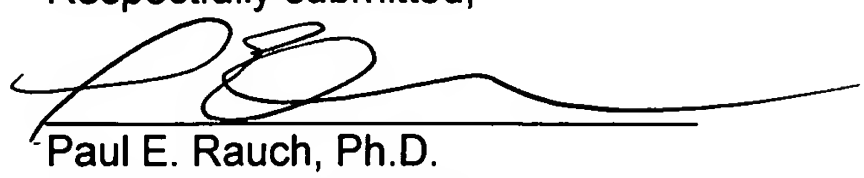
since improved etch selectivity will result in a higher yield of devices, or a significant improvement in the ease of fabrication of devices. In addition, the declarant states that these results are commensurate in scope with the claims, since the data provided would lead one of skill in the art to conclude that the results obtained from the specific example would be expected for all etching which falls within the scope of the present claims. Finally, since the claims specify the unexpected result, they are automatically commensurate in scope with the results.

As now claimed, the present invention specifies that the ratio of etch rates of metal silicide to poly-Si is at least 30. The applied references show an etch selectivity of at most 5, in systems where the authors were interested in high selectivity ratios. Applicant has provided a declaration which indicates that these results are superior and unexpected. Accordingly, Applicant submits that the claimed invention provides unexpected and superior results. Accordingly, these results demonstrate that the claimed invention is not obvious over the applied references. Withdrawal of this ground of rejection is respectfully requested.

Applicant respectfully requests that the declaration be considered. First, the present Office Action contains new grounds of rejection, which are addressed by the declaration. Second, applicant indicated in the last response that this declaration would be provided. Third, all the data described in the declaration was already present in the application. Finally, this declaration which specifies that the results are unexpected and superior, should place the application in condition for allowance. Accordingly, consideration of the declaration is respectfully requested.

Applicant submits the application is now ready for allowance. Early notice of such action is earnestly solicited.

Respectfully submitted,



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